Environmentally Preferred Advanced Generation's
California Advanced Combined Heat and
Power Collaborative

Draft Program Goals and Targets Workshops

May 13, 2003
8:00 – 12:00
Radisson Hotel
4545 MacArthur Blvd.
Newport Beach,
California

May 16, 2003
11:00 – 3:00
Loews Coronado Bay
Resort
4000 Coronado Bay Road
San Diego, California

Workshop Agenda

Introductions and Workshop Purpose (5 min.)
Mike Batham, California Energy Commission

PIER EPAG Program & CHP Initiative (10 min.)
Mike Batham, California Energy Commission

DOE CHP Integrated Energy Systems (15 min.)
Robert DeVault, ORNL (May 13) and
Chuck Collins, DOE Seattle Regional Office (May 16)

Draft CHP Program Goals & Targets (30 min.)
Allan Ward, California Energy Commission and
Keith Davidson, DE Solutions

CHP Program Discussion (3 hours)
All

Workshop Purpose

- Explain background of the PIER Program
- Discuss the advanced CHP Collaborative process
- Issue CHP solicitation late Summer
- Summarize DOE's CHP Program
- Discuss the draft CHP goals and targets

PIER Program

Background

- Established by California AB 1890 and SB 90 in 1996-97 and implemented in 1998**.**
- $62.5 million collected annually from investor-owned electricity utility ratepayers for “public interest” energy research, development and demonstration (RD&D) projects.

PIER Program Mission

- Conduct public interest energy research that seeks to improve the quality of life for California's citizens by providing environmentally sound, safe, reliable and affordable energy services and products.
- "Public interest energy research" includes the full range of RD&D activities that will (1) advance science or technology (2) is not adequately addressed by competitive or regulated markets.
- PIER is not a commercialization program.

PIER Program

Technical Subject Areas

- Environmentally Preferred Advanced Generation (EPAG)
- Energy Systems Integration
- Renewable Energy
- Industrial/Agricultural/Water Efficiency
- Building Efficiency
- Energy-Related Environmental

EPAG's Objectives

Advance the technical and market status of EPAG technologies so that installed systems will achieve:

- A low cost of electricity that is competitive with the grid
- Low environmental impact, especially low air emissions
- High reliability, availability, maintainability, durability, and usability
- Market connection.

Implied objectives:

- High fuel-to-electricity conversion efficiency
- Fuel Flexibility
- Dispatchability.

Advanced CHP Collaborative Process

- Build on RD&D currently being conducted
- Maximize end-user overall energy efficiency
- Enhance competitiveness of EPAG prime movers
- Focus on near to mid term results that maximize value
- Define technical barriers with RD&D solutions
- Identify research Targets and Goals
  - Discuss during workshops
  - Written comments to alward@energy.state.ca.us by Tuesday, May 27, 2003.

Issue a Solicitation and Fund Appropriate RD&D

- Details of the solicitation or potential projects will not be discussed today
- Solicitation will focus on identified Targets and Goals
- Projects will be selected competitively
- Approximately $6 million will be available
- Solicitation release date should be late summer
- Solicitation workshops will be scheduled

Presentation

on

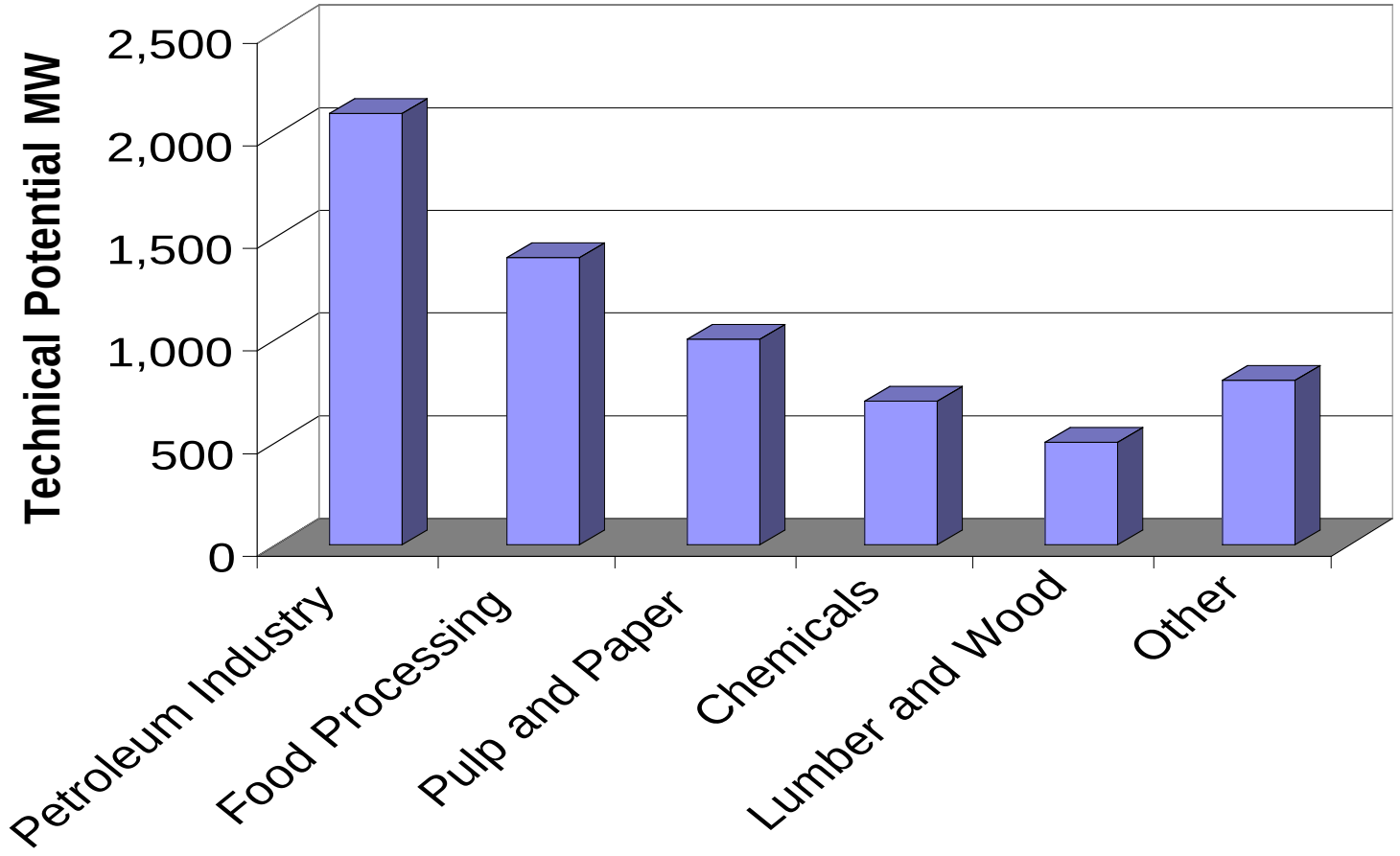
DOE CHP Integrated Energy Systems

Background & Perspective: Existing CHP in California

Fuel Type	• 90% use natural gas • Oil, coal, waste fuels and wood are minor contributors
Installed Base	• 5,700 MW (industrial) • 320 MW (commercial) • 480 MW (institutional)
System Size	• 25 MW (avg. industrial) • 1.3 MW (avg. commercial) • 2.4 MW (avg. institutional)
Technologies	• Reciprocating engines (66% of sites) • Combustion turbines (85% of installed capacity) • Fuel cells and micro-turbines (minor)

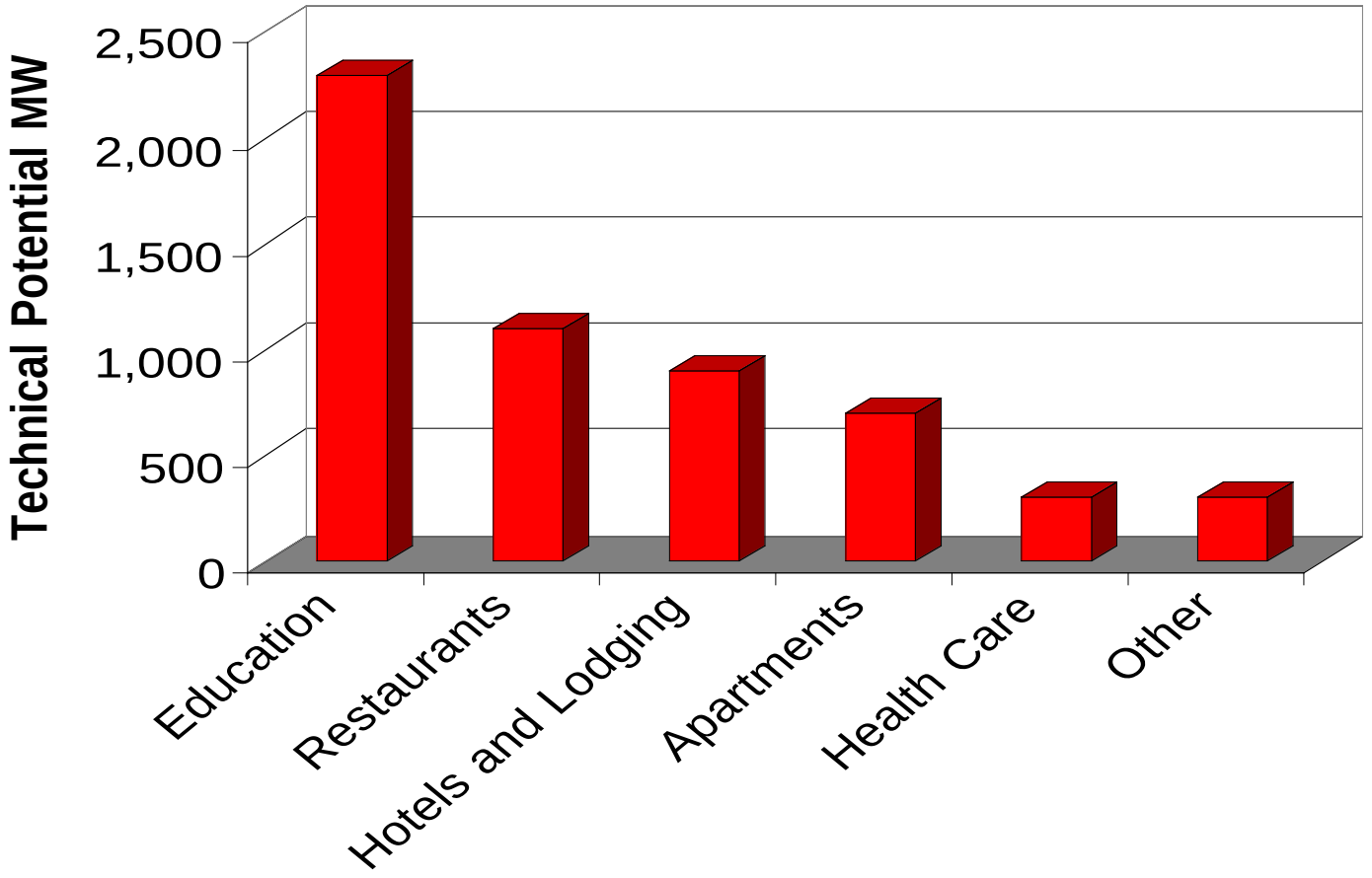
Background & Perspective:

6,500 MW of Industrial CHP Potential



Background & Perspective:

5,600 MW Commercial CHP Potential



Background & Perspective: Remaining CA CHP Market

- Smaller industrial, commercial & institutional applications
- Lack of steady heating loads coincident with electric demands
- Clean environmental requirements

Technological Advancements Needed

- Cost-effective, efficient, reliable and ultra-low emission prime movers – (important, but only part of the solution)
- Cheaper components requiring less maintenance
- Single source for integrated or packaged systems
- More efficient and effective use of low temperature heat
- Better integration with building HVAC systems
- Enhanced value of service
- Benchmarking Best Practices
- Matching and levelizing electric and thermal loads
- Integrated controls for CHP system components
- Accurate, user-friendly design tools

Scope of Proposed CHP Solicitation

- **Open to a wide spectrum of research projects**
  - Systems oriented
  - Focus on CHP and not improvements to prime mover cost, efficiency, or emissions.
  - Target meaningful, California markets
  - Represent advancements beyond the baseline, or what would naturally occur

Scope of Proposed CHP Solicitation

Acceptable Project Timeframes:

- Near-term projects (Less than 2 years to commercial introduction)
- Mid-term projects (3 to 4 years to commercial introduction)
- Emphasis on nearer-term projects.

Project Examples

Building Integrated Energy Systems

- **CHP/HVAC integrated packages**
- **Optimized absorption chiller designs**
  - reduced cost and size,
  - lower temperature heat utilization, increased COP,
  - reduced maintenance
- **Simple installation requirements (plug'n'play)**
- **Thermal storage to match system output and building needs**

Project Examples

Building Integrated Energy Systems, cont.

- Improve absorber interface with standard rooftop HVAC technology
- Develop low-cost hot water module for small CHP systems
- Develop system/building interface controls and operating diagnostics packages
- Design Benchmarking and Outreach

Project Examples

Industrial Process CHP

- Develop/demonstrate direct exhaust applications (eliminate HRSG)
- Optimize steam or advanced bottoming cycles such as Organic Rankine Cycle
- Develop low NO_X supplemental firing combustors for gas turbines
- Integrate high temperature fluid heating systems with CHP system
- Develop/integrate low temp. absorber for process refrigeration applications

Project Examples

Enhanced Value Markets

- **Integrate CHP with premium power/high reliability systems**
- **Develop/demonstrate real-time tracking system for integrated tariff designs, demand side response systems, and resource planning**
- **Improve CHP/utility interface for congestion management and maintenance scheduling**

Newport Beach Workshop Comments

- **Proposal evaluation should be application specific**
- **Need a common set of assumptions for economics -- energy prices, cost of capital, life and maintenance requirements**
- **Need Application Category Requirements -- sizes, E/T loads, noise, space, emissions**
- **Additional industrial application guidance, e.g. low NOx supplementary firing case**

Examples of Project Targets and Stretch Goals

The following examples are intended to be included in the solicitation and give guidance to applicants, but are by no means meant to be exclusive

Example 1: Small Commercial CHP Package

Parameter	Baseline	Near Term 2005	Mid Term 2007
size (kW)	100	100	100
Absorber size (tons)	25	28	35
Absorber COP	0.6	0.65	0.8
Package Cost ($/kW)	1500	1000	800
Installation Costs ($/kW)	1000	500	300
Emissions (CARB)	2003	2003	2007
Package Efficiency (HHV)	70%	75%	80%
Maintenance ($/kWh)	0.02	0.016	0.012
Availability	92%	94%	96%

Depends on heat from PM and efficiency of Chiller

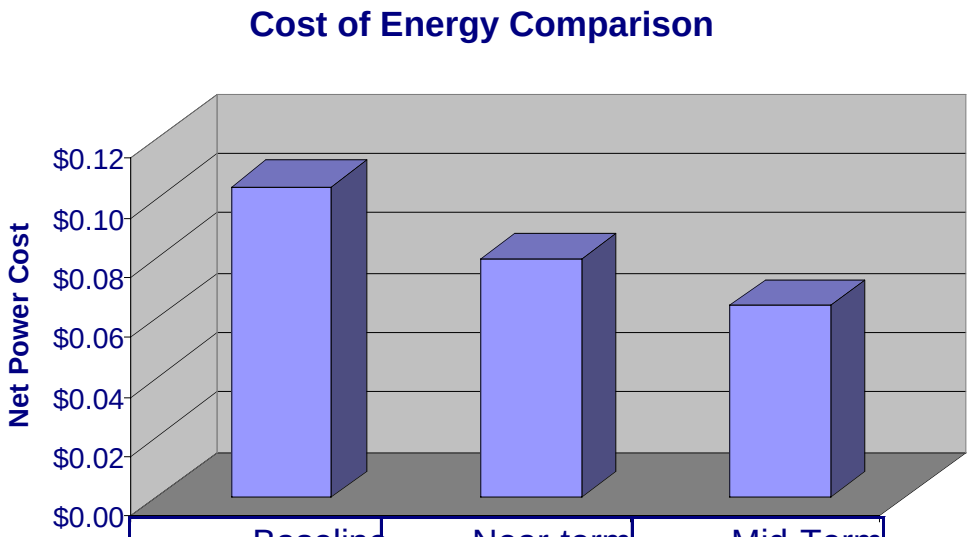
Measurement criteria?

Efficiency vs. value of TAT?

Example 1: Cost of Energy Comparison

Near-term 23% lower than Baseline

Mid-term 38% lower than Baseline



	Baseline	Near-term	Mid-Term
Carrying Chge (10%,10yr)	$40,686	$24,412	$17,902
Fuel Cost @ $5/MMBtu	$48,430	$47,112	$45,533
O&M Cost	$16,118	$13,175	$10,092
Total Annual Costs	$105,235	$84,699	$73,527
Avoided kW (HVAC)	25.5	28.56	35.7
Effective KW Provided	125.5	128.56	135.7
Effective Power Production kWh	1,011,430	1,058,614	1,141,183
Effective Cost/kWh	$0.1040	$0.0800	$0.0644

Example 2: High Reliability System for Data Center

Parameter	Baseline	Near Term	Mid Term
		2005	2007
Raised Floor Area (ft^2)	80,000	80,000	80,000
Size (kW)	15,000	15,000	25,000
Reliability (# 9s)	5	6	6
Installed Cost ($/kW)	$5,300	$4,000	$3,400
Overall Efficiency (HHV)	N/A	0.70	0.75
Absorber COP	N/A	0.65	1.00
Absorber Cost ($/ton)	N/A	$300	$250

Example 3: Integrated Cooling Module

Parameter	Baseline	Near Term 2005	Mid Term 2007
Size (tons)	100	100	100
Module Cost ($/ton)	$1,000	$700	$500
Absorber COP	0.60	0.65	0.80
Heat input Temp (^{o}F)	210	230	250

Example 4: Engine Heat Optimized Absorber

Parameter	Baseline	Near Term 2005	Mid Term 2007
Size (tons)	100	100	100
Absorber Cost ($/ton)	$400	$250	$200
Absorber COP	0.60	0.65	0.80
Heat input Temp (^{o}F)	210	230	250
Foot-print (ft^2)	84	55	45

Example 5: Supermarket CHP Refrigeration/Subcooling Package

Parameter	Baseline	Near Term 2005	Mid Term 2007
CHP Size (kW)	75-250	75-250	75-250
Chiller Size (tons)	20-90	20-90	20-90
Chiller Cost $/ton	$2,000	$1,200	$750
Chiller COP (on thermal input)	0.70	1.00	1.20
Maintenance ($/kWh)	$0.020	$0.020	$0.010
Integration	Separate	Integrated Module	Integrated System
Controls	Custom	Standard	Standard
Installed System Cost ($/kW)	$2,800	$1,800	$1,200
Overall Efficiency (HHV)	60%	65%	75%

Example 6: CHP Benchmarking

Parameter	Baseline	Near Term 2005	Mid Term 2007
size (kW)	500	500	500
Absorber size (tons)	100	110	130
Absorber COP*	0.60	0.65	0.80
Installed Cost ($/kW)	$2,000	$1,500	$1,200
Emissions (CARB)	2003	2003	2007
Package Efficiency (HHV)	70%	75%	80%
Maintenance ($/kWh)	$0.015	$0.012	$0.010
Availability	92%	94%	96%

* Example absorber COPs are for reciprocating engine-based systems. A turbine-based system should have higher COPs.

Example 7: Industrial Direct Heat CHP Package

Parameter	Baseline	Near Term	Mid Term
		2005	2007
Size (kW)	3,000	3,000	3,000
Equipment Cost ($/kW)	800	650	550
Installation Costs ($/kW)	500	350	250
Emissions (CARB)	2003	2003	2007
System Efficiency (HHV)	70%	75%	80%
Maintenance ($/kWh)	0.009	0.007	0.005
Availability	96%	97%	98%

Questions for Discussion

CHP Program Discussion

1. What are the appropriate CHP system attributes or boundaries? (electric power, thermal recovery system, thermal utilization technology, controls and application interface)

CHP Program Discussion

2. How should CHP systems be grouped for evaluation purposes?
    - By prime mover technology? (turbines, reciprocating engines, microturbines, fuel cells, other prime movers)
    - By electric output size? (0-500 kW, 500-2,000 kW, 2-5 MW, 5-30 MW, >30 MW)
    - By application? (industrial, commercial, by individual sector such as schools, supermarkets, food industry)
    - By thermal application? (steam, hot water, cooling, dehumidification, refrigeration, direct process air)

CHP Program Discussion

3. Within the ranges defined (#2) what is the most appropriate focus and emphasis for the Commission's program?

CHP Program Discussion

4. What are the appropriate targets and stretch goals for system attributes?
   - **Power generation efficiency?**
   - **CHP system efficiency? (how best to define this – the highest efficiency is not always focused on the highest value applications, e.g., low temperature hot water vs. a more valuable higher temperature application)**
   - **Package cost and capability? (including prime mover, generator, emissions controls, heat recovery, and system controls package)**
   - **Installation cost reduction? (engineering, onsite plumbing and electrical work, additional controls required, buildings and enclosures, other installation costs)**
   - **Maintenance cost reductions?**
   - **Reliability improvements?**
   - **Cost and performance for thermally activated technologies?**

CHP Program Discussion

5. As currently defined, do the targets and stretch goals appropriately reflect what is technically feasible for the range of important applications in California?

6. How can we make the targets more complementary to other CHP research efforts (i.e. DOE)?

CHP Program Discussion

7. Are relevant project examples left out, and if so, what parameters and targets should be associated with them?

Thank You For Attending

Follow-up contact information for questions or comments:

Allan Ward
California Energy
Commission
1516 9th St., MS 43
Sacramento, CA 95814
(916) 651-6196
alward@energy.state.ca.us